BLOOD PRESSURE

By CHARLES CLYDE SUTTER, M.D.
Rochester, N. Y.

Much attention is now being given to a study of arterial tension and clinicians are attaching special importance to the variations which the tension undergoes in different diseased conditions. Its determination is of special diagnostic import and often presents direct therapeutic indications. When incorporated as a part of every routine examination we are often able to detect a tendency to an abnormally high blood pressure before it begins to induce symptoms. Appropriate measures instituted at this time will usually keep the patient within the danger line.

To understand blood pressure fully let us recall that the blood travels in a circle, completing the circuit in man in about thirty seconds. The blood is driven out of the heart into the arteries by contractions of the ventricles of the heart. With each systole of the heart the arterial walls are stretched. After the completion of systole (diastole), the blood is driven onward in the arteries and into the capillaries by the elastic recoil of the arterial walls.

We are convinced that the blood exercises pressure upon the walls of the vessels containing it, because we know that the blood is forcibly injected into the arteries with each systole; the vessels are already full of blood; the arteries are highly distensible and stretch to accommodate the extra amount of blood forced into them; and that a distinct resistance is met between the arteries and veins by the minute arterioles and capillaries. The sectional area of the capillaries is several hundred times that of the aorta and the friction generated by the passage of the blood through these minute channels opposes a considerable hindrance or resistance in its course. This resistance is known as peripheral resistance.

The sum of all these factors, the propelling force of the heart, the volume and viscosity of the blood, the elasticity of the arteries and the resistance in the arterioles and capillaries, determines the amount of arterial tension.

The general or local flow of blood depends largely upon the relation between the heart's action and the peripheral resistance. The regulation of the amount of resistance to the passage of blood at the periphery is principally done by alteration of the calibre of the arterioles.

Normally the tone of an artery is maintained by the nervous system at about midway between extreme contraction and extreme dilatation.

Blood pressure varies greatly in different parts of the body. It is greater during systole than during diastole and is greatest in the ventricle and aorta near the heart and gradually diminishes toward the vessels more remote from the heart. In the veins it is nowhere great and changes but little in systole and in diastole. In the large veins near the heart the pressure becomes negative, suction rather than pressure.

All the factors upon which blood pressure depends vary constantly but are so combined that the general arterial pressure remains fairly constant. The blood pressure may be increased by increased force or frequency of the heart but this action is almost certainly followed by a diminished peripheral resistance. By this means the two altered conditions may balance and the blood pressure remain as it was before the heart began to beat more rapidly or more forcibly. Under pathological conditions this power of compensation may be lost, and hypertension or hypotension follow. This alteration will be transient or permanent depending upon whether the pathological condition is temporary or permanent.

Various instruments have been devised or modified from time to time to measure the amount of arterial blood pressure. In the scientific laboratory an artery of an animal is opened and the blood itself permitted to flow into a vertical glass tube of definite dimension, the pressure being indicated by the height to which the blood is forced; or the blood may be brought into contact with a definite amount of mercury contained in a graduated glass tube, either straight or U-shape, and the pressure determined by the height to which the mercury is forced; or a record is made by an indicator on a revolving smoked drum. Methods of this kind are not practical outside of the experimental or physiological laboratory. Vierordt estimated the blood pressure by placing weights on the radial artery until the pulse was obliterated. Marey devised a method of placing the hand in a closed vessel containing water. Pressure in this vessel was raised by connecting it by a tubing with a bottle. A second tube was connected with a tambor and a lever for recording the size of the pulse waves.

The earliest practical sphygmomanometers were those of Potain and Bouloumie. Their researches were chiefly confined to the pressure in the peripheral vessels. The Potain apparatus is composed of a dial manometer and an india rubber tube which ends in a small ampulla filled with air. The ampulla is applied over the radial artery so as to

obliterate the pulse. The number indicated by the needle expresses the arterial pressure in centimeters of mercury. The Bouloumie apparatus has, in addition, a rubber finger stall with which the end of the finger is compressed till the anemia is complete. The needle indicates the pressure produced by the reappearance of the circulation in the pulp of the finger. These methods have proven unsatisfactory as there is no way of comparing one with the other. With all forms of apparatus the estimation is relative and no standard can be made unless we can make comparisons. All instruments measure the maximum and minimum endovascular pressure but none of them measure the mass movement of the blood. There may be times when the systolic and diastolic pressures are normal and at the same time a marked stasis in the blood stream may exist. This is a very important feature which we must entirely neglect because of the lack of proper instruments.

The sphygmomanometers most commonly used at the present time consist of a pneumatic cuff which is applied to the arm above the elbow, with a tube leading from this cuff to a column of mercury, in one type, and to a dial in the other type. The pneumatic cuff is inflated so that it entirely obliterates the pulse in the forearm. The air is then allowed to escape until the blood is just permitted to pass through the constriction caused by the inflated cuff. At the first appearance of the pulse at the wrist a reading is made which gives the systolic or maximum pressure. More air is then permitted to escape until the movement up and down of the mercury suddenly becomes less or the hand of the dial reaches its greatest excursion and a second reading is made. This gives the diastolic or minimum pressure.

A distinct improvement was made by Korotkoff in 1905 on this method of using the sphygmomanometer by placing the bowl of a stethoscope below the cuff and exactly in the bend of the elbow and by listening for different sounds which appear. These sounds mark off five distinct phases, the first and last representing the systolic and diastolic pressures. The chief advantage of this auscultatory method is that the sense of hearing is substituted for the somewhat more fallible tactile sense. This method gives greater simplicity, ease and rapidity as well as greater precision and causes less disturbance to the patient than the slower methods which involve a longer compression with the armlet.

Many physicians determine only the systolic or maximum pressure. This determination has some value but does not tell half the story and may even give unwarranted alarming symptoms. No estimation of blood-pressure should be considered complete unless it includes the

mean pressure and pulse pressure as well as both systolic and diastolic pressures. It is only by the complete picture that we are able to determine the cardiac efficiency, the heart load and the pathogenesis of the various kinds of deviations from the normal blood-pressure. Repeated observations should be made and only those pressures which remain constantly above or below the normal should be considered hypertension or hypotension.

The normal blood-pressure for each person varies within certain limits which may, in a general way, be remembered by the rule formulated by Faught: "Consider the normal average systolic pressure of a male person at 20 years of age to be 120 mm. mercury, then add 1 mm. for every two years of life. For females the pressure would be approximately 10 mm. less than for males." According to this rule the systolic pressure in a person aged 30 years would be 125 mm.; at 40 years, 130 mm.; at 50 years, 135 mm. and at 60 years it would be 140 mm. The diastolic pressure is from 25 to 50 mm. mercury less than the systolic.

Blood-pressure varies greatly in different individuals and in the same individual under varying conditions. It is usually higher at night than in the morning, higher in the vertical position than in the sitting and higher in the sitting position than in the horizontal. It is affected by food, emotion, exercise and temperature. Extreme temperatures in bathing cause first a transient rise which is soon followed by a reduction in blood-pressure. Temperature of about 95°F. will be followed by a secondary rise in blood-pressure.

There is no distinct dividing line between a normal and a pathologic pressure. Many regard a pressure of 160 mm. mercury in a man past 50 years of age as being pathologic but no such distinct line can be established. In persons of a very nervous type, who are under the strain of overwork, worry and the like it may run up the point to 160, 170, 180 or even more. Here we have the toxemia associated with fatigue. These cases respond to the ordinary hygienic measures and do not necessarily mean disease. In arteriosclerosis and in nephritis we have a compensatory rise of blood-pressure which must be maintained. Below this point liver and kidney function would be impaired. With a continued systolic pressure of over 200 mm. mercury, there is always found some form of nephritis. In chronic interstitial nephritis a persistently high (160 to 250 mm.), systolic blood-pressure and a low diastolic pressure may be recognized before the urinary findings are present. Blood-pressure is not materially increased in the parenchymatous type of nephritis.

In every rise in blood-pressure we should determine, if possible, how much is due to intestinal toxemia and eliminate this if possible;

then we should determine whether the remaining rise is cardiac or nephritic. We must also know whether there is any atheroma present. We can then be better able to decide whether the pressure should be lowered and how much is safe. We have on the one hand the danger of hemiphlegia, if any atheroma be present and, if the pressure is lowered below the compensatory point, the danger of uremia or the loss of cardiac compensation.

Conditions other than disease influencing blood-pressure. Blood-pressure may be elevated by many drugs and by mechanical measures. The elevation may be either general or local, transient or lasting. The modus operandi of a general rise in blood-pressure may be through influence upon the rate or force of the heart by an increase in peripheral resistance through vaso-constriction or by a combination of both methods or by an increase in the volume of the vascular contents due to the introduction of normal saline solution.

Local rise in blood-pressure may be produced by forcing the blood from the peripheral vessels to the central arteries by the pneumatic jacket or by lowering the head and shoulders in shock. The opposite to the above will result in a lowered blood-pressure through the influence of cardiac depression, vascular dilatation, venesection, autocondensation current, rest, baths, and the elimination of causes.

Influence of Disease upon Blood-Pressure. Many diseased conditions directly or indirectly influence the blood-pressure. Some cause a rise (hypertension), others a fall (hypotension). This effect may be transient or permanent. Under the terms hypertension or hypotension should be considered only the alteration in which the blood-pressure remains constantly above or below the normal blood-pressure.

Hypertension may occur in such conditions as eclampsia, cerebral-hemorrhage, lead-poisoning, acute vascular affections, intestinal toxemia and diabetes. The more lasting or permanent rise in blood-pressure depends upon two factors, Bright's disease and arteriosclerosis. High tension is usually associated with cardio-vascular-renal disease but there may be high tension without signs of either arterial or renal disease. This is met in keen business men and is thought to be due to excessive adrenalin secretion. "Increasing blood-pressure is the most constant symptom of gestational toxemia in the latter half of pregnancy and is an invariable precursor of eclampsia" (Hirst). The first symptom of hypertension is a rise in the arterial and capillary tension. Later the heart beats become violent, the second aortic sound becomes ringing and the radial pulse hard. A white line made by the nail upon the cutaneous surface disappears in a few seconds.

Hypotension, as in case of hypertension, may be either transient or

lasting. It is present in most infectious diseases, in tuberculosis, in some acute cardio-vascular affections, in myocarditis, chronic pericardial affections, in many forms of poisoning, in exophthalmic goiter, in Addison's disease and in diminished secretion of the posterior lobe of the pituitary. It is a constant symptom in many relaxing disturbances as neurasthenia, chronic visceral disease, persistent vomiting, purging or hemorrhage and in malnutrition. In Addison's disease the pressure may fall as low as 70 or 80 mm. of mercury.

The symptoms of hypotension are usually blended with those of the associated condition. There is usually cyanosis and coldness of the extremities from sluggish peripheral circulation. The pulse is small and usually rapid. The white line made on the skin with the nail remains for a long time. There may be amaurosis without changes in the fundus of the eye; progressive changes in vision which follow the variations in the arterial tension; hypophoria, transient aphonia, suddenly appearing and disappearing, vertigo, general fatigue, perspiration of the hands and feet, associated with any nervous excitement or emotions. There may also be the associated symptoms of cardiac weakness, edema, passive congestion of the liver and oliguria.

Relation of Internal Secretions to Arterial Tension. Both hypertension and hypotension are usually due to peripheral vaso-constriction or vaso-dilatation, which may follow true lesions or spasmodic troubles or may be the result of toxic or mechanical phenomena. A very important rôle is played by the sympathetic nerves. There are many cases, however, where we must seek further for the cause and this will be found in some alteration of function of the glands of internal secretion. Changes have been found in the suprarenal glands which have led many to regard hypertension as a manifestation of hypersecretion of these glands. Cases of hypertension are now fairly well recognized which follow overactivity of the pituitary gland.

The pathogenesis of the hypotension in Addison's disease is proof of the insufficiency of the suprarenal secretion. It is possible that a similar insufficiency of the adrenals exists from other causes. Blood pressure can be artificially raised by the introduction of adrenalin, pituitrin and also from substances extracted from putrid meat showing the possibility of such causes in some cases. Injections of adrenalin in animals have caused glycosuria and also a form of arteriosclerosis probably due to high blood-pressure. There is much evidence to the contrary but it is rather generally accepted that adrenalin secretion has exclusively a pressor-effect on vascular tension.

The persistent rise in blood-pressure, seen in advanced age, seems to be directly due to the adrenals. The thyroids and adrenals show

lessened activity in advanced life and it is thought that the functional degeneration of the thyroid is more rapid than that of the adrenals. It is also recognized that a functional or permanent degeneration of the pituitary will result in hypotension.

High blood-pressure in cases of obesity which show no evidence of cardiac or renal disturbances and which do not respond to dietetic measures seems to be directly attributable to disturbances of internal secretion.

In conclusion, blood-pressure determinations should be a part of every examination. In persons of past middle life these determinations should be made periodically. In this way many cases of hemiplegia or uremia will be averted. Many cases of eclampsia will be recognized early and many cases of beginning cardiac failure will be discovered while there is still a chance of recovery. Its determination will aid in distinguishing between coma due to hemorrhage and that caused by thrombosis, as in the latter the blood-pressure is invariably low. It will often decide whether venesection should be employed. After the discovery of a high blood-pressure we must then seek for the etiology for it is only by understanding the cause that we can institute the proper measures. It should not be forgotten that high blood-pressure is nature's method of retaining compensation and undue lowering of the pressure may invite uremia.

FLORENCE NIGHTINGALE AND HER NURSES

By ELIZABETH ROBINSON SCOVIL

Gagetown, New Brunswick

There has been published this year a selection from Miss Nightingale's yearly addresses to the probationers and nurses of the Nightingale School at St. Thomas' Hospital, London. Those included are from 1876 to 1888. All that we can learn of the mind of this greatest of nurses is of value to the nursing profession. Some extracts from these addresses are presented in this paper at greater length than would be possible in an ordinary review of the book. Through them all runs that passion for righteousness, right feeling, right thinking, right living, which was the mainspring of Florence Nightingale's life.

She says: "Whether in having a drain cleaned out, or in ventilating a hospital ward, or in urging the principles of healthy construction of buildings, or of temperance and useful occupation, or of sewage and water supply, I always considered myself as obeying a direct command